

Item V:

Justified determination with respect to novelty, inventive step and industrial application; documents and declarations to support this determination.

- 1 Reference is made to the following document:
D1: US-A-3 736 969 (WARN H, SW ET AL) 5 June 1973 (1973-06-05)

2. INDEPENDENT CLAIM 1

- 2.1 Novelty

Document D1 is considered as the closest prior art with respect to the subject of claim 1. It discloses a functional element in accordance with the preamble of the claim.

The subject matter of claim 1 therefore differs in that a ring recess is provided between the ring-like bead and the free end face of the piercing section.

The subject matter of claim 1 is thus novel (PCT Article 33(2)).

- 2.2 Inventive step

The problem of increasing the strength of a component assembly when using thick sheet metal parts is solved in that, in addition to the use of the ring groove and the ring bead (see description of the application, page 18, lines 21 to 22), the ring recess permits an even firmer attachment of the functional element to the sheet metal part (see page 19, lines 12 to 20).

The solution proposed for this problem (object) in claim 1 of the present application is based on an inventive step for the following reasons (PCT Article 33(3)):

The available prior art does not give the skilled person any stimulation to such an arrangement of the ring recess.

3 INDEPENDENT CLAIM 27

3.1 Independence

Claim 27 does not contain all the features listed in claim 1. Claim 27 must therefore be considered an independent claim.

3.2 The subject matter of claim 27 differs from the functional element known from D1 in that the bead is of ring-like form.

The solution proposed in claim 27 of the present application cannot be considered inventive for the following reasons (PCT Article 33(3)): the bead is of ring-like form because the piercing section is also of ring-like form. A rivet with a ring-like piercing section is a typical design in the art.

4 INDEPENDENT CLAIM 34

4.1 Novelty

Document D1 is considered as the closest prior art with respect to the subject matter of claim 34. It discloses a component assembly in accordance with the preamble of the claim.

The subject matter of claim 34 therefore differs in that the sheet metal material at least partly fills out the ring recess.

The subject matter of claim 34 is thus novel (PCT Article 33(2)).

4.2 Inventive step

The reasons correspond mutatis mutandis to Item 2.2.

The solution proposed in claim 34 of the present application is therefore based on an inventive step (PCT Article 33(3)).

5 INDEPENDENT CLAIM 53

5.1 NOVELTY:

Document D1 is considered as the closest prior art with respect to the subject matter of claim 53. It discloses a method for the manufacture of a component assembly in accordance with the preamble of the claim.

The subject matter of claim 53 therefore differs in that the sheet metal material is formed into a ring collar surrounding the bead.

The subject matter of claim 53 is thus novel (PCT Article 33(2)).

5.2 Inventive step

The reasoning corresponds mutatis mutandis to Item 2.2.

The solution proposed in claim 53 of the present application is therefore based on an inventive step (PCT Article 33(3)).

6. INDEPENDENT CLAIM 57

6.1 Novelty

The available prior art discloses neither a functional element comprising the features of the preamble of claim 57 nor its method of manufacture in accordance with the characterizing portion of claim 57.

The subject matter of claim 57 is thus novel (PCT Article 33 (2)).

6.2 Inventive step

The available prior art does not give the skilled person either stimulation to such a functional element comprising a ring-like bead and a ring recess between the bead and the free end face of the pierced section nor to its method of manufacture.

The solution proposed in claim 57 of the present application is therefore based on an inventive step (PCT Article 33(3)).

7. DEPENDENT CLAIMS

Claims 2-26, 28-33, when considered as dependent on one of the claims 1-26, as well as dependent claims 35-52, 54-56 thus likewise satisfy the requirements of the PCT with respect to novelty and inventive step.

Although the known element can also be self-piercingly introduced into a sheet metal part, the element is not ideally designed for this purpose.

A further functional element which is at least similar to the element of EP 0 713 982 B1 at a first glance is known from EP 0 678 679 B1, but does not have a piercing section and is not suitable for the self-piercing introduction into a sheet metal part.

The object underlying the present invention is to provide a functional element of the initially named kind which is particularly suited for the self-piercing introduction into a sheet metal part, which can be manufactured at reasonable cost and which can also be used with a broad spectrum of sheet metal thicknesses, without the functional element having to have a special design for each sheet metal thickness.

In order to satisfy this object a functional element of the initially named kind is provided which is characterized in that a ring-like bead is provided at the piercing section between the ring-like contact surface and the free end of the piercing section and in that a ring recess is preferably provided around the piercing section between the bead and the free end face of the piercing section.

The diameter of the piercing section at the ring-like cutting edge can be larger than the maximum transverse dimension of the ring-like bead, but can also be of the same size or smaller than this maximum transverse dimension, i.e. than the diameter of an imaginary cylinder at the surface of which the apex of the bead lies.

Reference should be made at this point to US-A-3,736,969 which shows in Fig. 7 a self-piercing nut element, having a piercing section with a peripherally extending bead. Apart from the fact that the piercing section is square in cross-section, there is no ring recess between the bead and the free end face of the piercing section.

Reference should also be made to EP-A-0 133 087, which shows an element which is rectangular in plan view and the middle region of which, which is likewise rectangular, is bent up to form a type of bridge with the middle region of the bridge being shaped to form a cylindrical piercing section with a central thread. In accordance with Fig. 11, which only shows a section through the bridge part, the piercing section can likewise be provided with a peripherally extending bead. There is also no ring recess between the bead and the free end face of the piercing sections here.

Claims

1. Functional element (10) having a longitudinal axis (14), a body section (16), a hollow piercing section (18), a ring-like contact surface (20) at the body part, which extends substantially perpendicular to the longitudinal axis (14) and radially away from the piercing section (18) and an axially extending ring groove (21) which is provided in the body section radially inside the contact surface (20), with the functional element (10) being designed for attachment to a component (22) which is of plate-like shape at least in the region of the attachment, in particular to a sheet metal part, wherein the body section (16) has a pressing surface (24) at the side remote from the piercing section and wherein ribs (26) providing security against rotation are provided which cross the ring groove (21) at least in part and wherein the free end of the piercing section is provided with a ring-like cutting edge (30), characterized in that
a ring-like bead (32) is provided at the piercing section (18) between the ring-like contact surface (20) and the free end (28) of the piercing section (18) and in that a ring recess (34) is provided around the piercing section between the bead (32) and the free end face (28) of the piercing section.
2. Functional element in accordance with one of the preceding claims, characterized in that
the ring-like cutting edge (30) either projects radially further outwardly than the apex (31) of the bead (32) or projects outwardly to the same extent or projects less far outwardly, i.e. that the diameter of the ring-like cutting edge (30) is larger than, smaller

than or of the same size as the maximum transverse dimension of the bead (32), i.e. as the diameter of an imaginary cylinder (106) on the surface of which the apex (31) of the bead (32) lies.

3. Functional element in accordance with claim 1 or claim 2, characterized in that the ring groove (21) runs out via an at least substantially conical surface (36) into the ring-like contact surface (20).
4. Functional element in accordance with any one of the preceding claims, characterized in that the ring-like bead (32) has an at least substantially triangular shape when seen in an axial section plane.
5. Functional element in accordance with any one of the preceding claims, characterized in that the ring recess (34) extends radially within the ring-like bead (32) and is preferably bounded by the ring-like bead (32) at the side remote from the free end face (28) of the piercing section (18).
6. Functional element in accordance with any one of the preceding claims, characterized in that the ring recess (34) is at least substantially U-shaped when seen in an axial section plane and preferably has at least substantially the shape of a semi-circle.

7. Functional element in accordance with claim 7,
characterized in that
it is formed as a hollow fastener element and has a fastener section (13) provided for the reception of a bolt.
8. Functional element in accordance with one of the preceding claims,
characterized in that
the body section (16) has a flange section (40), with the ring-like contact surface (20) and the axially extending ring groove (21) being provided at or in the flange section (40) at its side facing the piercing section (18).
9. Functional element in accordance with claim 8,
characterized in that
the fastener section (13) has one of the following designs:
 - a) it is located at the side of the flange section (40) remote from the piercing section (18),
 - b) it is located at the side of the flange section (40) remote from the piercing section (18) and extends at least partly into the flange section (40),
 - c) it is located at the side of the flange section (40) remote from the piercing section (18) and extends through the total axial thickness of the flange section (40),
 - d) it is located at the side of the flange section (40) remote from the piercing section (18) and extends through the total axial thickness

of the flange section (40) and also through a part of the axial length of the piercing section (18),

e) it is located at the side of the flange section (40) remote from the piercing section (18) and extends through the total axial thickness of the flange section (40) and also through the total axial length of the piercing section (18),

f) it is located at the side of the flange section (40) adjacent the piercing section (18) and extends through a part of the axial thickness of the flange section (40) and also through a part of the total axial length of the piercing section (18),

g) it is located at the side of the flange section (40) remote from the piercing section (18) and extends through a part of the axial thickness of the flange section (40) and also through the total axial length of the piercing section (40),

h) it is located at the side of the flange section (40) adjacent the piercing section (18) and extends only through the total axial length of the piercing section (18),

i) it is located at the side of the flange section (40) adjacent the piercing section (18) and extends only through a part of the total axial length of the piercing section (18).

10. Functional element in accordance with one of the preceding claims, characterized in that
the ring-like cutting edge (30) at the free end of the piercing section (18) forms the transition between a cylinder surface (56) at the outer

side of the piercing section (18) and a ring-like end face (54) of the piercing section (18).

11. Functional element in accordance with claim 10, characterized in that the cylinder surface (56) is a cylinder surface of a circular cylinder.
12. Functional element in accordance with claim 10 or claim 11, characterized in that a ring-like discontinuity is located between the cylinder surface (56) and the U-shaped ring recess (34).
13. Functional element in accordance with one of the claims 1 to 9, characterized in that the ring-like cutting edge (30) at the free end of the piercing section (18) forms the transition between a conical surface tapering in the direction of the flange section at the outer side of the piercing section (18) and a ring-like end face (54) of the piercing section (18).
14. Functional element in accordance with claim 13, characterized in that a ring-like discontinuity is located between the conical surface and the U-shaped ring recess (34).
15. Functional element in accordance with claim 13, characterized in that the conical surface tapering in the direction of the flange section merges continuously without discontinuity into the U-shaped ring recess (34).

16. Functional element in accordance with one of the preceding claims, characterized in that
the axial length between the apex point (31) for the bead (32) and the free end face (28) of the piercing section (18) lies in the range between 1 and 4 mm.
17. Functional element in accordance with one of the preceding claims, characterized in that
the axial spacing between the apex point (31) of the bead (32) and the ring-like portion (20) of the contact surface which lies in a plane perpendicular to the longitudinal axis (14) lies in the range between 0.2 and 2 mm.
18. Functional element in accordance with one of the preceding claims, characterized in that
the radial depth of the ring recess (34) measured from the apex point (31) of the bead (32) lies in the range between 0.5 and 2 mm.
19. Functional element in accordance with claim 10 or claim 11, characterized in that
the axial length of the cylinder surface (56) amounts to 0.3 to 2 mm.
20. Functional element in accordance with claim 13, characterized in that
the axial length of the conical surface amounts to 0.3 to 2 mm.
21. Functional element in accordance with one of the preceding claims, characterized in that
ribs (26) providing security against rotation are provided in the ring groove (21).

22. Functional element in accordance with one of the preceding claims, characterized in that
the base surface of the ring groove (21) is provided on at least a part of its radially extent with noses (26) providing security against rotation and/or with grooves (84) providing security against rotation.
23. Functional element in accordance with one of the preceding claims, characterized in that
ribs (26) providing security against rotation are provided which bridge the peripherally extending ring groove (21).
24. Functional element in accordance with one of claims 21 to 23, characterized in that
ribs (26) providing security against rotation or noses providing security against rotation do not project in the axial direction beyond the ring-like section (20) of the contact surface which lies in a plane perpendicular to the longitudinal axis and are preferably set back slightly relative to the latter.
25. Functional element in accordance with one of the preceding claims, characterized in that
ribs (26) providing security against rotation are provided which extend in raised manner within the ring groove (21) in the axial direction up to the bead (32), i.e. at least substantially have a rectangular shape with two limbs.
26. Functional element in accordance with claim 25, characterized in that

the axially extending sections (26') of the ribs (26) providing security against rotation do not project in the radial direction beyond the apex point (31) of the bead (32) and are preferably set back slightly radially with respect to the apex point (31).

27. Functional element in accordance with claim 1, characterized in that
the piercing section is formed in the region below the bead (32) in cylindrical manner without ring recess (Fig. 5).
28. Functional element in accordance with one of the preceding claims, characterized in that
the ring-like bead (32) has the form of at least one turn of a thread.
29. Functional element in accordance with one of the claims 1 to 27, characterized in that
the bead (32) has the form of at least two sections (32', 32'') of a turn of a thread.
30. Functional element in accordance with one of the claims 1 to 27, characterized in that
the bead (32) has the form of sections (32', 32'') of a turn of a left hand thread and of a turn of a right hand thread which are alternately arranged around the longitudinal axis (14).
31. Functional element in accordance with claim 30, characterized in that
the turn sections (32', 32'') are connected to one another and preferably form a closed ring.

32. Functional element in accordance with claim 31, characterized in that in total four turn sections (32', 32'') are provided.
33. Functional element in accordance with one of the claims 25 to 26, characterized in that the axial sections (26') of the ribs (26) providing security against rotation are of different length.
34. Component assembly comprising a sheet metal part (22) and at least one functional element (24) with a longitudinal axis (14), with a body section (16), a hollow piercing section (18), a ring-like contact surface (20) at the body part, which extends substantially perpendicular to the longitudinal axis (14) and radially away from the piercing section (18) and an axially extending ring groove (21) which is provided in the body section radially inside the contact surface (20), with the functional element being designed for attachment to a component (22) which is of plate-like shape at least in the region of the attachment, in particular to a sheet metal part, wherein the body section has a pressing surface (24) at the side remote from the piercing section and wherein ribs (26) providing security against rotation are provided which cross the ring groove (21) at least in part and wherein the free end (28) of the piercing section (18) is provided with a ring-like cutting edge (30), characterized in that a ring-like bead (32) is provided at the piercing section (18) between the ring-like contact surface (20) and the free end (28) of the piercing section (18); in that a ring recess (34) is provided around the piercing section between the bead (32) and the free end face (28) of the piercing section (18);

in that material of the sheet metal part (22) contacts the contact surface (20) and at least substantially fills out the ring groove (21) and in that the sheet metal part has a piercing in the region of the piercing section through which the piercing section (18) extends, with the bead (32) being received in a ring-like groove (90) in the marginal zone of the piercing.

35. Component assembly in accordance with claim 34, characterized in that the sheet metal part (22) has a ring-like recess (88) around the piercing and at the side remote from the contact surface (20).
36. Component assembly in accordance with claim 34, characterized in that the sheet metal part (22) has a ring-like projection (86) around the piercing and at the side remote from the contact surface (20), with the ring-like projection at least partly surrounding the bead (32) and in that a ring-like recess (90) surrounds the ring-like projection (86).
37. Component assembly in accordance with claim 35 or claim 36, characterized in that the ring-like recess (90) in the sheet metal part is surrounded by a planar surface (96) which lies in a plane perpendicular to the longitudinal axis (14) of the fastener element.
38. Component assembly in accordance with claim 37, characterized in that the body section (16) has a flange section (40) with the ring-like contact surface (20) and the axially extending ring groove (21) being provided at or in the flange section (40) at its side facing the piercing

section (18) and in that the planar surface (96) lies at least partly opposite to the flange section (40) and to the ring-like contact surface (20).

39. Component assembly in accordance with one of the claims 34 to 38, characterized in that
the ring groove (21) extends radially within the ring-like bead (32) or is bounded at the piercing section side by the ring-like bead (32) and in that the sheet metal material part also fills out this region of the ring groove (21).
40. Component assembly in accordance with claim 39, characterized in that,
in the region radially within the ring-like bead (32), the ring groove (21) has at least substantially the shape of the semi-circle in an axial section plane.
41. Component assembly in accordance with one of the claims 34 to 40, characterized in that
the ring bead (32) has an at least substantially triangular shape in an axial section plane and in that the ring-like groove (90) has the same shape in the marginal zone of the piercing.
42. Component assembly in accordance with claim 34 to 41, wherein the fastener element is formed as a hollow fastener element (10) and has a fastener section (13) provided for the reception of a bolt, characterized in that:

a) it is located at the side of the flange section (40) remote from the piercing section (18),

b) it is located at the side of the flange section (40) remote from the piercing section (18) and extends at least partly into the flange section (40),

c) it is located at the side of the flange section (40) remote from the piercing section (18) and extends through the total axial thickness of the flange section (40),

d) it is located at the side of the flange section (40) remote from the piercing section (18) and extends through the total axial thickness of the flange section (40) and also through a part of the axial length of the piercing section (18),

e) it is located at the side of the flange section (40) remote from the piercing section (18) and extends through the total axial thickness of the flange section (40) and also through the total axial length of the piercing section (18),

f) it is located at the side of the flange section (40) adjacent the piercing section (18) and extends through a part of the axial thickness of the flange section (40) and also through a part of the total axial length of the piercing section (18),

g) it is located at the side of the flange section (40) remote from the piercing section (18) and extends through a part of the axial thickness of the flange section (40) and also through the total axial length of the piercing section (40),

h) it is located at the side of the flange section (40) adjacent the piercing section (18) and extends only through the total axial length of the piercing section (18),

i) it is located at the side of the flange section (40) adjacent the piercing section (18) and extends only through a part of the total axial length of the piercing section (18).

43. Component assembly in accordance with one of the preceding claims,
characterized in that
the ring recess (34), when considered in an axial section plane, has at least substantially the shape of a semi-circle and in that the sheet metal material at least partly fills out the ring recess.
44. Component assembly in accordance with one of the claims 34 to 43,
characterized in that
the ribs (26) providing security against rotation extend in raised manner within the ring groove (21) in the axial direction up to the bead, i.e. have an at least substantially rectangular shape with two limbs and in that the sheet metal material is formed around the two limbs of the ribs providing security against rotation.
45. Component assembly in accordance with claim 44,
characterized in that
the axially extending sections (26') of the ribs providing security against rotation do not project in the radial direction beyond the apex (31) of the bead (32) and are preferably arranged set back slightly radially relative to the apex.

46. Component assembly in accordance with one of the claims 34 to 45, characterized in that
the axially extending sections (26') of the ribs (26) providing security against rotation do not project in the axial direction beyond the ring-like contact surface (20) or only fractionally beyond the ring-like contact surface (20).
47. Component assembly in accordance with one of the claims 34 to 46, characterized in that
the ring-like bead (32) has the shape of at least one turn of a thread.
48. Component assembly in accordance with one of the preceding claims 34 to 46, characterized in that
the ring-like bead (32) has the shape of at least two sections (32', 32'') of one turn of a thread.
49. Component assembly in accordance with one of the preceding claims 34 to 46, characterized in that
the bead (32) has the form of sections (32', 32'') of a turn of a left hand thread and of a turn of a right hand thread which are alternately arranged around the longitudinal axis (14).
50. Component assembly in accordance with claim 49, characterized in that
the turn sections (32', 32'') are connected to one another and preferably form a closed ring.

51. Component assembly in accordance with claim 50, characterized in that a total of four turn sections (32', 32'') are provided.
52. Component assembly in accordance with claim 45 and one of the claims 47 to 51, characterized in that the axial sections (26') of the ribs providing security against rotation are of different length.
53. Method for the manufacture of a component assembly in accordance with one or more of the claims 34 to 52, characterized by the following steps:
 - a) the sheet metal part (22) is supported on a die button (60) which has a bore (62) having a diameter (D) which is designed to receive the ring-like cutting edge (30) of the functional element (10), with the bore (62) of the die button (60) being surrounded by a ring projection (64) which merges at the side radially remote from the bore into a surface (66) perpendicular to the longitudinal axis (68) of the bore, with the longitudinal axis (68) of the bore being at least substantially aligned with the longitudinal axis (14) of the functional element,
 - b) the functional element (10) is moved in the direction towards the sheet metal part (22) and the die button (60) lying beneath it and a piercing slug (80) is removed from the sheet metal part (22) by the ring-like cutting edge (30), with the piercing slug (80) being received by the bore (62; 63) of the die button or disposed of through it,

c) at the same time as the cutting out of the piercing slug (80) or thereafter, the sheet metal material is shaped by the movement of the body part (16) towards the sheet metal part (22) and the die button (60) by means of the ring projection (64) into the ring groove (21) and around the bead (32) as well as at least partly into the ring recess (34) in order to produce a form-locked connection between the sheet metal part (22) and the functional element (10).

54. Method in accordance with claim 53, characterized in that, on the shaping of the sheet metal material (22) by the ring projection (64), the sheet metal material is also formed around or into the features providing security against rotation, i.e. the ribs (26) providing security against rotation.
55. Method in accordance with one of the claims 53 or 54, characterized in that the sheet metal material (22) in the region of the functional element radially outside of a recess caused by the ring projection (62) is pressed flat by the said surface (66) of the die button which stands perpendicular to the longitudinal axis (68).
56. Method in accordance with one of the preceding claims 53 to 55, characterized in that the sheet metal material (22) is shaped into a ring collar (86) surrounding the bead (32).
57. Method for the manufacture by cold forming of a functional element (10), in particular of a functional element in accordance with one of the claims 1 to 33, the functional element having a longitudinal axis

(14), a body section (16), a hollow piercing section (18), a ring-like contact surface (20) at the body part, which extends substantially perpendicular to the longitudinal axis (14) and radially away from the piercing section (18) and an axially extending ring groove (21) which is provided in the body section (16) radially inside the contact surface (20), wherein the body section (16) has a pressing surface (24) at the side remote from the piercing section (18) and wherein ribs (26) providing security against rotation are provided which cross the ring groove at least in part and wherein the free end of the piercing section (18) is provided with a ring-like cutting edge (30), wherein a ring-like bead (32) is provided at the piercing section (18) between the ring-like contact surface (20) and the free end of the piercing section (18) and wherein a ring recess (34) is provided around the piercing section between the bead (32) and the free end face of the piercing section, characterized by the following cold forming steps:

a) an initially cylindrical blank is made in one or more steps into a blank (120) for the functional element (10) with the end face of the cylindrical portion and also the opposite end of the blank each being indented to form respective indents (128; 132) and the body part (18) with the ring groove (21) and a cylindrical section (136), which is later shaped into the piercing section (18), and also optionally features (26) providing security against rotation being produced in the region of the ring groove (21) and/or at the cylindrical section (136),

b) material adjacent to the end face of the cylindrical section is shifted in the direction towards the ring-like groove (21) to form the ring-like bead (32) while reducing the outer diameter of the

cylindrical section (136) in the region of its end face, wherein, on the formation of the bead (32) in the form of a turn of a thread or of a plurality of sections (32'; 32'') of a thread, the ribs (26; 26'') providing security against rotation are also shaped at their free ends,

c) in a further step, the end face of the functional element (10) is deformed and enlarged in diameter in order to form the cutting edge (30) at the end face of the cylindrical section and a ring groove (34) around the cylindrical section between the end face of the cylindrical section and the bead,

d) the thus finished manufactured blank is subsequently pierced or is simultaneously pierced by means of a hole punch in the region between the two indents (130, 132) and, if desired, the pierced region is subsequently provided with a thread.